



NASA STTR 2016 Phase I Solicitation

T1 Launch Propulsion Systems

Launch Propulsion Systems reflects a staged development of critical technologies that include both “pull” technologies that are driven by known short- or long-term agency mission milestones, as well as “push” technologies that generate new performance or mission capabilities over the next 20 to 25 years. While solid and liquid propulsion systems are reaching the theoretical limits of efficiency, they have known operational and cost challenges while continuing to meet critical national needs. Improvements in these launch propulsion systems and their ancillary systems will help maintain the nation’s historic leadership role in space launch capability. Newer technologies like air-breathing launch propulsion, unconventional, and other propulsion technologies and systems, while low in TRL, can radically transform the nation’s space operations and mission capabilities and can keep the nation’s aerospace industrial base on the leading edge of launch technologies.

Subtopics

T1.01 Affordable Nano/Micro Launch Propulsion Stages

Lead Center: MSFC

Participating Center(s): AFRC, KSC

There has been recent significant growth in both the Quantity and Quality of Nano and Micro Satellite Missions:

- The number of missions has outpaced available ride share opportunities.
- Dedicated access to space increases small sat mission capability & allows new & emerging low-cost technologies to be flight qualified.

Stage concepts are sought that can be demonstrated within the scope & budget of a Phase II STTR project:

- MSFC is actively pursuing multiple technologies to significantly reduce orbital access cost.
- The scale of many Nano and Micro Launch vehicles allows stages to be completed within the scope and budget of a Phase II proposals.
- Accepted proposals will be limited to stages that “plug and play” into existing or proposed architectures for orbital launch vehicles with payload capabilities from 5-50 kg. A flight test is expected in Phase II.
- The university/small business partnership is ideal to provide the correct technology combination allowing for this affordable access to space.

State of the Art

Small launch vehicles are targeting a total launch cost of ~\$1-2M. Proposed stages must demonstrate significant cost savings over state of the art.

What is the compelling need for this Subtopic?

- This subtopic is necessary because there are currently no available rides for experimental propulsive stages.
- Technological advancements like additive mfg. must be demonstrated to produce aerospace quality parts at low fixed cost. These technologies must be validated for use in propulsive stages.
- The correct combination of new technologies and approaches will enable affordable, dedicated, on-demand access to space.
- Technologies that are demonstrated and validated at the nano/micro scale can be robustly infused into large launch vehicles where loads and vibrations are not as severe.
- The success of Nano/Micro Launch vehicles benefit every NASA center by enabling unprecedented experimental access to space.
- Commercial development opportunities abound since the small satellite market is robust and growing.

STMD/NASA/NARP/National-Affordable access to space is a key objective for NASA. The Nano/Micro Launch scale is an affordable avenue that will enable the development and validation of key technologies and approaches to reduce fixed cost, recurring costs and range costs.

T1.02 Detailed Multiphysics Propulsion Modeling & Simulation Through Coordinated Massively Parallel Frameworks

Lead Center: MSFC

Participating Center(s): SSC

Detailed modeling and simulation to assess combustion instability of recent large combustors while successful to a degree showed the need for significant advances in two-phase flow, combustion, unsteady flow, and acoustics. Additionally, simulation of water spray systems for launch acoustic sound suppression and test stand rocket engine acoustic sound suppression showed the need for advances in two-phase flow, droplet formation, and particulate trajectory. In these cases, and others, the need for improved physics based models is accompanied by the requirement for high fidelity and computational speed.

Rocket combustion dynamic simulations are 3D, multiphase, reacting computations involving the mixing of hundreds of individual injection elements which require a long time history to be computed. Methods are sought (VOF, SPH, DNS/LES, PIC, etc.) to accurately capture the physics of the injection elements in a computationally efficient manner. Experimental validation of individual submodels are required.

NASA successfully leveraged advances/ innovation in computer science technology to leapfrog the barriers to massive parallelism via the adoption of the Loci framework in the late 1990's. Computer science has evolved in the last two decades with respect to technology of massive parallelism. The intent of this subtopic is to infuse newest technologies, i.e., improved physics based models accompanied by the requirement for high fidelity and computational speed, into tools for propulsion related fluid dynamic simulation. This solicitation seeks simultaneously coordinated computer science (CS) technology advances, multi-physics (MP) simulation, and high fidelity (HF) models. The value and requirement for proposals is this coordinated CS-MP-HF framework. Ideally, technologies that are up to this point only Lower TRL demonstrations are strong candidates if they are developed to fit in a coordinated CS-MP-HF framework that can be applied to propulsion system fluid dynamics.

Tools developed in this framework are expected to enable propulsion system production & DDT&E cost reductions.